

said designated logical volume is allocated by said comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table; and selecting a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.

REMARKS

In the Office Action mailed July 2, 2002, claims 1, 3, 5, 7, 9, 11, and 13-16 were rejected under 35 USC §103(a) as being unpatentable over Tanaka et al. (U.S. Patent No. 5,542,064), in view of Joho, (U.S. Patent No. 5,408,634). The foregoing rejections are respectfully traversed.

In accordance with the foregoing, claims 1, 3, 7, and 13-15 have been amended, and claims 5, 9, 11, and 16 are canceled. Moreover, new claims 17 and 18 are added.

A Version with Markings to Show Changes Made to the claims is included herewith. Care has been exercised to avoid the introduction of new matter.

Claims 1, 3, 7, 13-15, 17, and 18 are pending and under consideration. Claims 1, 7, 13-15 are independent claims. Claims 3 and 17 depend either directly or indirectly from claim 1 and claims 11 and 18 depend either directly or indirectly from claim 7.

Tanaka discloses that the object is to enhance the input/output throughput of a secondary storage device having a plurality of storage units as disclosed in column 2, lines 25-30, and the attaining method is to select storage units less in the degree of waiting for processing of input/output commands as a group of storage units to be subjected to multiple writing of identical data in a secondary storage device having a plurality of storage units, as described in column 2, lines 54-60.

But, the selecting step and accessing step of Tanaka are different from that of the present invention. These steps of Tanaka are disclosed in column 7, lines 65 to column 8, and lines, and in Fig. 7 in Tanaka.

In step S605 and S610 of Tanaka, idle disk drives having the requested data are selected, and in steps S620 and S625, plural disk drives having the objective data are selected unless the number of the selected disk drives reaches the threshold 1 (see column 8, lines 31-37). Moreover, in S630, a number of output commands are generated correspondingly to the number of the selected disk drives, and in S635-645, "when a report of achieving a connection to one of the disk drives 16-1 to 16-n receiving output commands output commands of disk drives except the first connected disk drive are cancelled."

That is, the selecting and accessing steps in Tanaka discuss selecting less waiting disk drives, not a minimum waiting single disk drive as in the present invention, and to output the commands to the less waiting plural disk drives and connect first connected single disk drive, not output commands to the single minimum waiting disk drive as in the present invention.

Joho discloses a multiple disk system that queues a new access only in the disk unit having the minimum waiting time. Joho does not disclose a multiple disk system that queues a new access only in the disk unit having the minimum waiting operation number, as in the present invention.

Each of independent claims 1, 7, and 13-15 of the present application recites (using the recitation of claim 1 as an example) that a single disk unit is selected to access a designated logical volume based upon the "minimum number of operations".

Neither Tanaka or Joho, either alone or in combination, discusses or suggests same.

Moreover, the above-mentioned dependent claims recite patentably distinguishing features of their own. For example, claim 3 (depending from claim 1) recites "'a resource manager circuit determining one of the plurality of physical disk units to be accessed in accordance with said number of operations in said memory in response to a transfer request from said channel adapter circuit, and requesting said device adapter circuit to perform an operation accessing said determined physical disk unit'".

In addition, the Japanese Patent Office has issued a first Office Action in a counterpart Japanese patent application with two references. One reference (JP60-205641 by Fujitsu) discloses a volume accessing method for accessing one physical volume among a plurality of physical volumes storing a logical volume and having a pair of counters for counting the request number of each physical disk and for queuing a new access in minimum counting number disk.

Another reference (JP 3-253933 by Fujitsu) discloses a multiple disk system for alternately accessing plural disks and having a table indicating an abnormal disk number.

To clarify the patentably distinguishing features of the present invention over the foregoing references, each of independent claims 1, 3, 7, and 13-15 of the present application are amended to recite "to determine which selection is performed to select a single minimum waiting drive disk or to select a normal disk drive in accordance with status information of the physical disk in the memory".

In addition, new claims 17 and 18 are added to define a table construction for the foregoing feature of the present invention.

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.


Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please cancel claims 5, 9, 11, and 16.

Please AMEND claims 1, 3, 7, and 13-15 as follows:

1. (EIGHT TIMES AMENDED) A RAID apparatus comprising:
a plurality of physical disk units storing a plurality of copies of each of logical volumes;
and
a disk controller accessing any of the physical disk units which stores a designated logical volume to thereby access said designated logical volume,
said disk controller including:
a memory storing the number of operations requested to each physical disk unit,
for each physical disk unit, and
control means for accessing one of said plurality of physical disk units which stores the designated logical volume, in accordance with said number of operations,
wherein said control means compares numbers of operations corresponding to a plurality of physical disk units which store said designated logical volume with each other, selects the single physical disk unit from among the disk units storing the designated logical volume which has a minimum number of operations based on the comparison, and outputs a request to only the selected single minimum waiting physical disk unit,
wherein said control means increments the number of operations of said selected physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation,
wherein each of said physical disk units performs requested operations in a queued order, and
wherein said memory stores a table indicating [a correspondence of] the plurality of physical disk units [and] corresponding to each of said [designated] logical volume and status information indicating statuses of said physical disk units; and said control means refers to said memory with said designated logical volume, and selects [to select] said single physical disk

unit on which said designated logical volume is allocated [in accordance with said designation of said designated logical volume by a high-rank apparatus] by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information and selects a normal physical disk unit among said plurality of physical disk units when said status information indicates abnormal.

3. (AS TWICE AMENDED) The RAID apparatus according to claim 1, wherein said control means includes:

a channel adapter circuit performing interface control with said high-rank apparatus;
a device adapter circuit accessing said physical disk units in accordance with a requested operation; and

a resource manager circuit determining one of the plurality of physical disk units to be accessed in accordance with said number of operations in said memory in response to a transfer request from said channel adapter circuit, and requesting said device adapter circuit to perform an operation accessing said determined physical disk unit.

5. (CANCEL)

7. (SEVEN TIMES AMENDED) An access control method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, and a disk controller accessing any physical disk unit which stores a designated logical volume to thereby access said designated logical volume, said method comprising:

determining a plurality of physical disk units which store a designated logical volume;
and

selecting from among the determined disk units storing the designated logical volume one of said determined physical disk units in accordance with the number of operations requested to said physical disk units, said selecting comprising:

comparing said numbers of operations of a plurality of physical disk units which store said designated logical volumes with each other,

accessing the single physical disk unit which has a minimum number of operations based on the comparison and outputting a request to only said selected single minimum waiting physical disk unit,

incrementing the number of operations of said accessed physical disk unit in accordance with a request for said operation, and

decrementing the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said plurality of physical disk units performs requested operations in a queued order, and

wherein said selecting further comprises referring to a memory storing a table indicating [a correspondence of] the plurality of physical disk units [and] corresponding to each of said [designated] logical volume and status information indicating statuses of said physical disk units, and

[to select a] selecting said physical disk unit on which said designated logical volume is allocated [in accordance with said designation of said designated logical volume by a high-rank apparatus] by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information and selects a normal physical disk unit among said plurality of physical disk units when said status information indicates abnormal.

9. (CANCEL)

11. (CANCEL)

13. (SEVEN TIMES AMENDED) A RAID apparatus comprising:

physical disk units storing redundant logical volumes, a first of the redundant logical volumes being stored on one of the physical disk units, and a second of the redundant logical volumes being stored on another of the physical disk units; and

a disk controller counting numbers of operations respectively requested of each of the physical disk units and accessing one of the first and the second of the redundant logical volumes based on a minimum number of the numbers of operation respectively requested of each of the physical disk units storing the redundant logical volumes based on the counting, and outputting a request to only the accessed single minimum waiting physical disk unit,

wherein said disk controller increments the number of operations of an accessed physical disk unit in accordance with a request for said operation and decrements the number of operations of an accessed physical disk unit whose operation has been completed, in

accordance with an end of said operation,

wherein each of said physical disk units performs requested operations in a queued order, and

wherein said disk controller refers to a table indicating [a correspondence of] the plurality of physical disk units [and] corresponding to each said redundant logical volumes [to select] and status information indicating statuses of said physical disk units; selects the accessed single physical disk unit on which one of said redundant logical volumes is allocated [in accordance with said designation of said one of said redundant logical volumes by a high-rank apparatus] by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information and selects a normal physical disk unit among said plurality of physical disk units when said status information indicates abnormal.

14. (SIXTH TIMES AMENDED) A RAID controller accessing one of a plurality of physical disk units storing a plurality of copies of each of logical volumes to thereby access a designated logical volume, comprising:

a memory storing a number of operations requested of each physical disk unit corresponding to each physical disk unit; and

a controller comparing said numbers of operations corresponding to a plurality of physical disk units which store a designated logical volume with each other, and selecting single one of said plurality of physical disk units which has a minimum number of operations from among the plurality of physical disk units storing the designated logical volume based on the comparison and outputting a request to only said selected single minimum waiting physical disk unit,

wherein said controller increments the number of operations of said selected physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation, wherein each of said plurality of physical disk units performs requested operations in a queued order, and

wherein said memory stores a table indicating a correspondence of the plurality of physical disk units and said designated logical volume; and said controller refers to said memory with said designated logical volume to select a physical disk unit on which said

designated logical volume is allocated in accordance with said designation of said designated logical volume by a high-rank apparatus.

15. (SIXTH TIMES AMENDED) A balancing access method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, comprising:

comparing numbers of operations of a plurality of physical disk units which store a designated logical volume with each other;

selecting a single one of said physical disk units which has a minimum number of operations from the disk units storing the designated logical volume based on the comparison and outputting a request to only said selected single minimum waiting physical disk unit;

incrementing the number of operations of said accessed physical disk unit in accordance with a request on said operation; and

decrementing the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation, wherein each of said physical disk units performs requested operations in a queued order, and

wherein said selecting further comprises referring to a memory storing a table indicating [a correspondence of] the plurality of physical disk units [and] corresponding to each of said [designated] logical volume and status information indicating statuses of said physical disk units; [to select] and selecting said single physical disk unit on which said designated logical volume is allocated [in accordance with said designation of said designated logical volume by a high-rank apparatus, and wherein said balancing access method auto-adjusts loads between the physical disk units] by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information and selects a normal physical disk unit among said plurality of physical disk units when said disk unit among said plurality of physical disk units when said status information indicates abnormal.

16. (CANCEL)

Please ADD new claims 17 and 18.

17. (NEW) The RAID apparatus according to claim 1, wherein said table in the memory comprising:

a logical volume structure table storing statuses and said plurality of physical disk units of each logical volume; and

a disk management table storing statuses and the number of operations of each physical disk unit,

and wherein said control means refers to said logical volume structure table with said designated logical volume, and selects said single physical disk unit on which said designated logical volume is allocated by aid comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table and selects a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.

18. (NEW) The access control method according to claim 7, wherein said referring comprises referring said memory comprising a logical volume structure table storing statuses and said plurality of physical disk units of each logical volume and disk management table storing statuses and the number of operations of each physical disk unit,

and wherein said selecting comprising: selecting said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table; and selecting a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.